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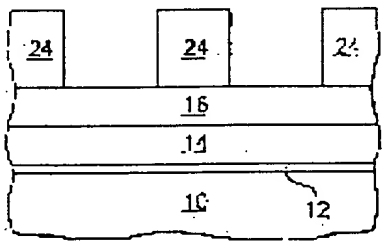
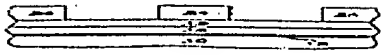
(54) SEMICONDUCTOR TREATMENT METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an optical assist layer for optimizing a profile of resist patterns.
SOLUTION: A pad oxide 12 and a nitride layer 14 are formed on a substrate, and an optical assist layer 16 is formed before deposition of resist. Thereafter, a resist layer is deposited to form resist patterns 24. These resist patterns 24 have a straight sidewall due to presence of the



optical assist layer 16 and does not form a resist 'foot' under the resist patterns 24. A thickness of the optical assists layer 16 is optimized so as to reduce/remove interference between the resist layer and a substrate 10, and accordingly the resist 'foot' is reduced/removed.



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* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Generally this invention relates to a semiconductor art and the method of optimizing the profile of the photoresist especially used for lithography.
[0002]
[Background of the Invention] If the scale down of the semiconductor device is carried out in the direction (the thickness direction) of z, the thin film used for formation of a semiconductor device will become thin inevitably. This is the right to the hard surface mask blank layer using the step which forms trench separation. Trench separation is used in order to separate the device of each other electrically. It contains the step which uses the pattern of a photoresist, etches a hard surface mask blank layer layer [hard surface mask blank], i.e., in order to deposit the layer of the oxide and nitride of a thin pad generally, to form the pattern of a photoresist on a hard surface mask blank layer and to form a hard surface mask blank, and etches a semiconductor substrate using a hard surface mask blank after that. It is desirable to decrease the thickness of the nitride layer used in the direction of z in carrying out the scale down of the semiconductor device at a hard surface mask blank. If the thickness of a nitride layer is changed into it being inconvenient, the optical effect which is not desirable will be produced. As especially shown in drawing 1 , it is generated at the pars basilaris ossis occipitalis of the photoresist 18 by which "foot (foot)" 20 were patternized. In addition to being dependent on the thickness of a nitride, "foot" 20 are dependent also on a stepper's wavelength. Drawing 1 is the abbreviation formed on about 150A pad oxide 12 formed on the semiconductor substrate 10, and the oxide layer 12. The resist pattern 18 formed on 1,500A the nitride layer 14 and the nitride layer 14 is shown. "foot" 20 are as a result of other layers 12 which exist a resist pattern 18, a

substrate 10, and between them, and the optical interaction between 14. Change of the thickness of a nitride increases homogeneity, and it is needed in order to decrease a defect. However, formation of "foot" 20 arises by changing the thickness of the nitride layer 14 to 1,500 ** from 2,000 **. If a resist pattern 18 is not the same width of face in the upper part and the lower part, the hard surface mask blank formed using the nitride layer 14 in the bottom of it has the mistaken pattern size. Furthermore, when "foot" 20 corrode during etching, a hard surface mask blank has the side wall which the inclination attached. ** and "foot" 20 cannot be easily seen in top-down SEM (scanning electron microscope: scanning electron microscope) measurement at last.

[0003] The conventional method for solving this problem has a step using the resist which adjusted the thickness of a resist, and added non-reflexibility coating (upper part and lower part), and the color attached. However, all of these methods are resists "a foot". It does not remove appropriately. Therefore, resist "a foot" There is the need for the method of decreasing or removing.

[0004]

[Summary of the Invention] This invention has added the optical assistant layer between the nitride layer of a hard surface mask blank, and a resist layer. This optical assistant layer is the transparence or the translucent layer which has the refractive index of a nitride, and a different refractive index. For example, a TEOS (tetraethyl oxy-silane) layer can be used. An optical assistant layer changes the optical interference between a resist layer and a substrate, and is a resist "a foot". Formation is decreased / removed.

[0005]

[Embodiment of the Invention] This invention will be explained with the phot lithography process used for formation of trench separation. Probably, it will be clear to this contractor of this field that it is applicable to other foot problems which do not contain the phot lithography and the hard surface mask blank of others which are used in order that the advantage of this invention may form LOCOS separation. If drawing 2 is referred to, in order to form a hard surface mask blank, the desired layer (they are layers 12 and 14 in this case) used continuously will deposit on a substrate 10. Generally, a hard surface mask blank consists of a layer 12 of a pad oxide, and a layer 14 of a nitride. The pad oxide layer 12 has the thickness of 150A order, and the nitride layer 14 is. It has the thickness of 1,500A order. However, probably this invention will not be limited to the configuration of this specific hard surface mask blank, but its pile of other hard surface mask blanks (stack) will be clear to this contractor of this field.

[0006] Next, the optical assistant layer 16 deposits on a layer 14. As for this optical assistant layer 16, it is desirable to have the transparence or the translucent material which has the refractive index of a layer 14 (nitride in this case) and a

different refractive index. For example, the optical assistant layer 16 contains TEOS. Other examples contain BPSG (borophosphosilicate glass: boron Lynn silica glass), non-TEOS silicon die oxide, an aluminum oxide, and a zincic acid ghost. The thickness of the optical assistant layer 16 is optimized based on specific application. The factor which should be taken into consideration has the refractive index of a **** material, if it chooses to the thickness of a layer 14, the thickness of all the layers under a layer 14 (layer 12 in this case), the refractive index of these layers, and an optical assistant layer. as an example -- the thickness of a 150A pad oxide (layer 12) -- and -- Optical assistant layer which contains TEOS to the thickness of a 1,500A nitride layer (layer 14) It can be made 2,000A order.

[0007] After the optical assistant layer 16 deposits, the photoresist layer 22 is formed on the optical assistant layer 16. As shown in drawing 3 , the resist layer 22 is exposed and etched in order to form a resist pattern 24. By existence of the optical assistant layer 16, a resist pattern 24 does not contain a "foot" in the lower part of a pattern. The optical interference between the resist layer 22 and a substrate 10 decreases by the optical assistant layer 16, and a "foot" is removed. A resist pattern 24 is used as a mask, and as shown in drawing 4 , in order to form a hard surface mask blank 26, it etches layers 14 and 12. When there is no resist "a foot", the improved hard surface mask blank 26 which has the straight side wall 28 and has the pattern which is in agreement with the upper part of a resist pattern 24 arises. A resist pattern 24 is removed after formation of a hard surface mask blank 26. If , the optical assistant layer 16 may also be removed at this point. However, the layer 16 may be left behind to the location to the point after a process. Next, a trench is etched into a substrate 10. This trench can be filled up with the conventional material used in order to form trench separation.

[0008] It depends for the thickness of the optical assistant layer 16 on the thickness and the refractive index of a layer (they are layers 12 and 14 in this case) which lie downward greatly. When a layer 14 has a nitride, it is [as seeming / the optical assistant layer 16 / to be unnecessary] actually possible to adjust the thickness of a nitride layer. However, it is not necessarily advantageous to adjust a nitride layer in suitable thickness. For example, the defect of a nitride layer also increases and homogeneity decreases as the thickness of a nitride increases. On the other hand, making a nitride layer thin is making it hardly leave a nitride, in order to attain the continuing process step. An above-mentioned thing is right regardless of the configuration of the layer under a resist layer, and only not being limited to a nitride should be taken notice of. It should also be taken notice of that the optical assistant layer 16 serves to prevent the optical interference between substrates to a resist. The path which the non-reflective coating of the upper part and the lower part absorbs does not absorb interference. it is thought that the

optical assistant layer 16 adjusts where at which point namely, the period -- the standing wave from exposure of a photoresist contacts a substrate. This influences the interference between a resist layer and a substrate, and the pattern to produce.
[0009] Drawing 5 (A)-(D) shows the result of having changed the thickness of the optical assistant layer 16. On a pad The nitrated case which has the thickness of 1,500A is used. TEOS is used to the optical assistant layer 16. Drawing 5 (A) The thickness of the 2,000A optical assistant layer 16 is shown, and a resist "a foot" is not found. The thickness of the optical assistant layer 16 of drawing 5 (B) and 2,250 A is shown, and few resists "a foot" are beginning to form. The thickness of the optical assistant layer 16 of drawing 5 (C) and 2,500 A is shown, and a clear resist "a foot" is accepted. Finally the case of drawing 5 (D) and the optical assistant layer 16 which has the thickness of 2,750 A is shown, and a resist "a foot" is still more remarkable. The thickness of 2,000A may not be the optimal to the thickness of other advantageous however nitrides, and the configuration of an optical assistant layer to the above-mentioned example. The thickness of an optical assistant layer needs to be optimized to the specific condition that it is used.
[0010] Although this invention was explained about the illustrated operation gestalt, it does not have the intention of this explanation being interpreted by the limited semantics. Probably, various modification and combination of an operation gestalt which were illustrated will be clear to this contractor of this field like other operation gestalten of this invention. Therefore, it is meant that a claim includes all modification and embodiments. Each following item is indicated in relation to the above publication.
(1) The method characterized by to have the step which forms the optical assistant layer which is the phot iso GURAFI method and has the step which forms at least one layer on a substrate, and a refractive index which is translucent at least and is different from said at least one layer on said at least one layer, the step which forms a photoresist layer on said optical assistant layer, and the step which forms a resist pattern from said photoresist layer.
[0011] (2) A method given in the above (1) characterized by using a RESHISUTO pattern furthermore in order to form a hard surface mask blank, and having the step which etches said optical assistant layer and said at least one layer.
(3) Said at least one layer is a method given in the above (1) characterized by having a nitride layer.
(4) A method given in the above (3) furthermore characterized by including a pad oxide between said nitride layers and said substrates.
(5) Said optical assistant layer is a method given in the above (1) characterized by including TEOS.
(6) Said optical assistant layer is a method given in the above (1) characterized by

including a transparent material.
[0012] (7) Said optical assistant layer is a method given in the above (1) characterized by having the refractive index of a nitride, and a different refractive index.
(8) It is a method given in the above (1) characterized by for said at least one layer having the nitride which has the thickness of 1 or 5000A order, and said optical assistant layer containing TEOS which has the thickness of 2 or 0000A order.
(9) The step which is the method of forming a hard surface mask blank, and forms a pad oxide on a substrate, The step which forms a nitride layer on said pad oxide, and the step which forms the optical assistant layer which has a refractive index which is translucent at least and is different from said nitride layer on said nitride layer, It has the step which forms a photoresist layer on said optical assistant layer, and the step which forms a resist pattern from said photoresist layer. In order to optimize the thickness of said photoresist layer so that the resist pattern which has the width of face of the upper part almost equal to lower width of face may be formed, and to form said hard surface mask blank The method characterized by having the step which etches said optical assistant layer, said nitrated case, and said pad oxide, and the step which removes said resist pattern, using said resist pattern as a mask.
[0013] (10) A method given in the above (9) characterized by having the step which furthermore removes said optical assistant layer after the step which removes said resist pattern.
(11) Said optical assistant layer is a method given in the above (9) characterized by including TEOS.
(12) Said optical assistant layer is a method given in the above (9) characterized by including a transparent material.
(13) It is a method given in the above (9) characterized by for said nitride layer having the thickness of 1 or 5000A order, and said optical assistant layer containing TEOS which has the thickness of 2 or 0000A order.
(14) This invention relates to the optical assistant layer (16) for optimizing the profile of a resist pattern (24). It is formed on a pad oxide (12) and a nitride layer (14) GA substrate, and an optical assistant layer (16) is formed before deposition of a resist. A resist layer deposits after that and it is formed in resist PATANN (24). By existence of an optical assistant layer (16), this resist pattern (24) has a straight side wall, and does not form a resist "a foot" in the lower part of a resist pattern (24). The thickness of an optical assistant layer (16) is optimized so that interference between a resist layer and a substrate (10) may be decreased / removed, therefore it decreases / removes a resist "a foot."

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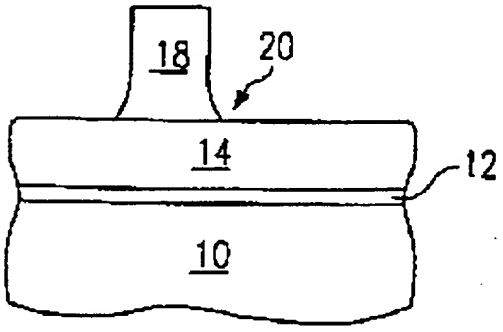
CLAIMS

[Claim(s)]
[Claim 1] A method characterized by to have a step which forms an optical assistant layer which is the phot iso GURAFI method and has a step which forms at least one layer on a substrate, and a refractive index which is translucent at least and is different from said at least one layer on said at least one layer, a step which forms a photoresist layer on said optical assistant layer, and a step which forms a resist pattern from said photoresist layer.

[Translation done.]

Drawing selection | drawing 1



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[Translation done.]

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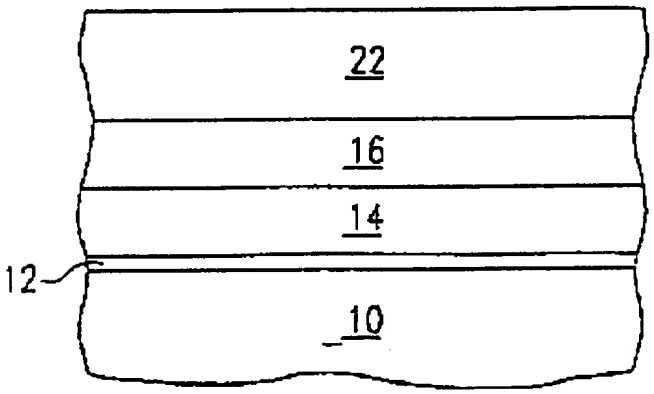

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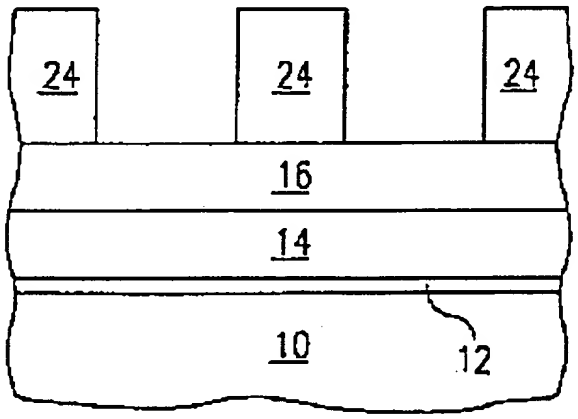

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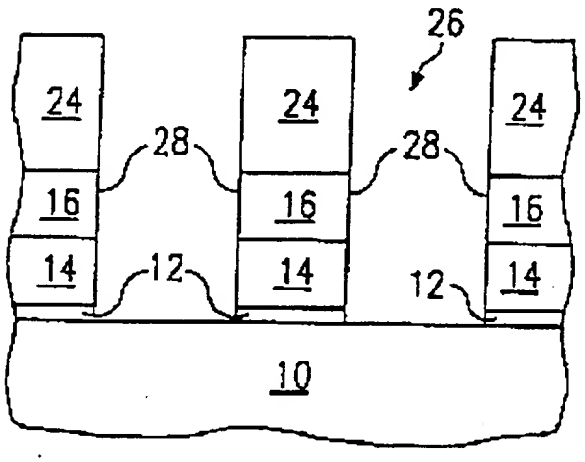
Drawing selection | drawing 4



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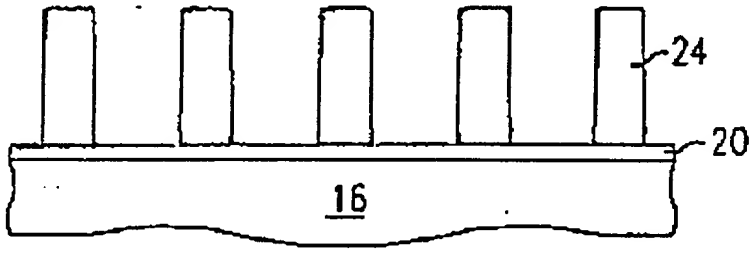
Drawing selection | drawing 5

(A)



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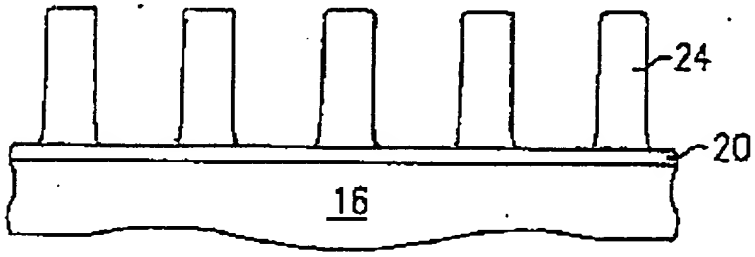
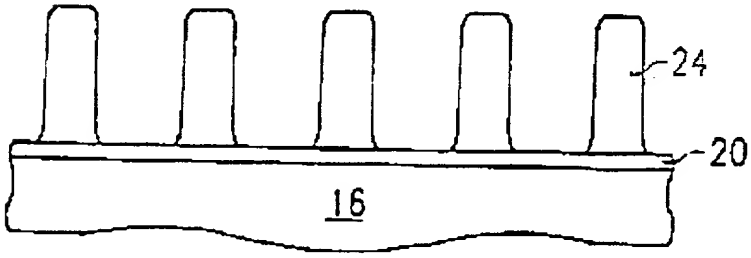


(C)



(D)